Chapter 8

Specific Situations

This chapter contains a review of specific patient care situations that require special interventions. It does not include every clinical situation, but is intended to review several specific medical conditions and the effects of altitude on those problems. Patient care situations that do not have specific air medical concerns are not mentioned. This does not mean that stressors of flight do not affect patients with conditions not mentioned in this chapter.

Specific patient care protocols are outlined in *The Alaska Medevac Manual*, which includes model protocols that cover most diagnoses. Each service must consult with its medical control physician for further guidance in patient care.

Aspects of patient care and packaging guidelines are also discussed in Chapters 6, 7, and 11.

Learning Objectives

Upon completion of this chapter, the participant should be able to:

- List four components of patient assessment.
- List four differences in the assessment of pediatric patients.
- Describe the three components in the Pediatric Assessment Triangle.
- List four medical conditions that benefit from transport in an aircraft with sea level cabin pressurization.
- List three problems that can occur as a result of rapid ascent and descent in an aircraft.
- Explain one step air medical escorts can take during flight preparation for patients with:
    - Ventilatory support.

- Burns.
- Orthopedic injuries.
- Spinal injuries.

- List four items that should be in the "comfort kit" to address voiding during an air medical transport.
- List six interventions BLS air medical escorts can perform for patients with dive injuries.
- List four things air medical escorts can do to create a less stressful environment for psychiatric patients who must be transported by air.
- List seven complications that can be present during pregnancy.
- List two conditions that may require air medical transportation for pregnant women.
- List five conditions that should be met when transporting neonatal patients by air.

Patient Assessment

A thorough history and physical examination should be performed on every patient before transport. This is best accomplished in a controlled, quiet environment such as a clinic, but this is not always possible. The following surveys are adapted from the *State of Alaska Standing Orders and Treatment Protocols for All Levels, December 2003*.

Scene Size-Up

Responders should scan the scene of an incident thoroughly when approaching it to determine:

- That the scene is safe.
- The mechanism of injury or the nature of the illness.
- The number of patients.
- Whether additional assistance is needed.

Report from Sending Personnel

This report should be given as soon as escorts arrive at the patient's location.

- If possible, every member of the medical crew should listen to the verbal report from sending personnel before starting an examination of the patient. This lessens the chance of missing key data and may reduce duplication of effort.
- The report should include a detailed history, pertinent physical exam findings, and description of treatment completed by the sending facility.

If the patient's condition requires immediate interventions, the interventions take priority over the verbal report.

Initial Assessment for Adult Patients

The initial assessment looks for life-threatening conditions. Any life-threatening condition found during the initial assessment must be treated immediately. The steps are:

1. Form a general impression—this can be performed from across the room. Does the patient look sick?
2. Determine responsiveness/level of consciousness (AVPU):
   - **A**lert
   - Responds to **V**erbal stimuli
   - Responds to **P**ainful stimuli
   - **U**nresponsive
3. Determine the chief complaint, if the patient is conscious.
4. Assess the **Airway**; open and maintain the airway as needed.
5. Check **Breathing** (is breathing adequate or inadequate) and assist patient as necessary.
6. Check **Circulation** and initiate CPR, if necessary.
7. Look for and control any life-threatening **hemorrhage**.
8. Assess skin for signs of adequate perfusion (e.g., color, temperature, condition).
9. Identify any life threatening situation/s, such as severe airway compromise or inadequate chest wall expansion.

Focused History and Physical Examination of Adult Patients

The next step in patient assessment is a focused history and head-to-toe physical examination. Transportation should not be delayed to accomplish these parts of the assessment. It should be completed after

life-threatening conditions have been stabilized.

It consists of the following steps:

1. Determine the chief complaint if not already done during the initial assessment.

    - For medical patients:

        - Get the history of the present illness (HPI). The OPQRST tool may be helpful, especially when the patient has pain:

        - **O**nset—what was the patient doing when the symptom/s started?

        - **P**rovoking/palliative factors—does anything make the symptom/s better or worse?

        - **Q**uality—if there is pain, describe how it feels (e.g., sharp/dull, crampy/constant, etc.). If the patient had this pain before, is anything different this time?

        - **R**adiation—does the pain go anywhere or stay in one place?

        - **S**everity—rate the symptom/s on a scale. Some commonly used scales include:

            - 0–10 with ten being the worst possible

            - The Faces Scale

        - **T**ime—what time did the symptom/s start, how long has it lasted? If the patient has several symptoms, which came first, then next, etc.

    - For trauma patients:

        - Look for a serious mechanism of injury (MOI):

            - Ejection from a vehicle.

            - Rollover motor vehicle crash.

            - High speed crash with severe vehicle deformity.

- Fall over 20 feet.
- Pedestrian versus vehicle crash.
- All-terrain vehicle (ATV/four-wheeler)/snowmachine/motorcycle crashes.
- Penetrating wounds to the head, chest or abdomen.

- Perform a rapid trauma assessment looking again for other life-threatening conditions:
  - Reassess AVPU.
  - Quickly assess head, neck, chest, abdomen and pelvis. This involves quickly looking and feeling along the patient's body. Some people use a mnemonic like DCAP-BTLS (deformities, contusions, abrasions, punctures/penetrations, burns, tenderness, lacerations, and swelling) as a tool to help with this assessment.

3. Get a SAMPLE history:
   - **S**igns and symptoms of the problem.
   - **A**llergies the patient has.
   - **M**edications the patient is taking.
   - **P**ast medical history of the patient.
   - **L**ast oral intake of the patient.
   - **E**vents leading to the illness/injury.
4. Assess the patient's current health status.
5. Assess the patient's baseline vital signs.
6. Perform a detailed physical head-to-toe examination of the patient:
   - Palpate the posterior cervical spine.
   - Inspect and palpate the head.

- Inspect and palpate the forehead and facial structures.
- Inspect the pupils for size and reaction to light.
- Inspect the nostrils.
- Assess the mouth for foreign bodies, secretions, and odor.
- Examine the ears, including the external ear canals.
- Examine the mastoid processes for bruising.
- Inspect and palpate the anterior neck and trachea.
- Inspect and palpate the shoulder girdle.
- Inspect, auscultate, and palpate the chest. Watch for symmetry and depth of respirations.
- Inspect and palpate the abdomen. Hearing bowel sounds may be difficult in the field or on board an aircraft.
- Inspect the pelvis and genitalia, if indicated.
- Compress the pelvic girdle and note any instability.
- Inspect and palpate the lower extremities. Be sure to assess circulation, movement, and sensation (CMS) in the lower extremities.
- Inspect and palpate the upper extremities. Check CMS in the upper extremities.
- Log-roll the patient to inspect and palpate his or her spine, back and buttocks.
- Obtain vital signs including pulse, blood pressure, respiration, skin color, and skin temperature. In children, check capillary refill time.
- Check for medical alert tags, like an Alaska Comfort One, DNR bracelet, or MedicAlert® jewelry.

7. Ongoing patient assessments should be performed periodically throughout the transport as indicated by the patient's condition. Generally this is every 5 minutes in an unstable patient and every 15 minutes in a stable patient. The steps in the ongoing assessment include:

   - Repeat the initial assessment, ensure that the patient's airway, breathing and circulation are adequate.
   - Reassess and record vital signs.
   - Repeat the focused assessment of the patient's complaint or injuries.
   - Assess all interventions such as:
     - IV sites are intact and secured; fluids are flowing well.
     - IV infusions contain the correct medication and are being administered at an appropriate flow rate.
     - Foley catheter is draining well. Monitor the urine output.
     - Splints that have been applied are secure. Check that CSM is intact distal to the site of the injury.
     - Patients who are on backboards are well secured. Backboards should be padded.
     - Breath sounds are reassessed after moving intubated patients.
   - Review key diagnostic tests such as:
     - Electrocardiogram (ECG) rhythm/findings.
     - Laboratory results related to the diagnosis.
     - X-ray findings. Special attention should be given to chest x-rays if a pneumothorax (air in the pleural space) is suspected or patients are intubated. Free air on abdominal films may indicate the need for sea level cabin altitude.
     - CT Scans.

General Care for Pediatric Patients

Children are anatomically and physiologically different from adults. They create special challenges for the air medical escort. Children may be frightened and unable to verbalize what is wrong. Below are some tips to help reduce stress for younger patients:

- Assess very young children while their parents or caregivers are holding them.
- Approach children at their level; avoid towering over children.
- Use a calm and reassuring tone.
- Explain to children what will happen during the flight.
- Be honest.

Initial Assessment of Pediatric Patients

Children have the ability to look good for a long time, and then suddenly decline. Air medical escorts must be alert for subtle changes in patient condition.

One tool that is very useful for quickly and easily assessing a child is the Pediatric Assessment Triangle (PAT)[1] developed by the American Academy of Pediatrics. The PAT is an "across the room" survey with three basic parts:

- **Appearance** assesses mental status, muscle tone, and body position.
- **Work of breathing** assesses visible chest movement, effort, audible sounds, and retractions.
- **Circulation to skin** assesses skin color.

Components of an initial assessment consists of the following steps:

- Determine the child's level of consciousness using the AVPU scale.
- Assess the **Airway**, open and maintain the airway as needed.

Pediatric Assessment Triangle

R. Dieckmann, D. Brownstein and M. Gausche-Hill, (eds.), *Pediatric Education for Prehospital Professionals*, 2000, Jones and Bartlett, Sudbury, MA, www.jbpub.com. Reprinted with permission.

[1]R. Dieckmann (eds.), *Pediatric Education for Prehospital Professionals*, (2nd ed.) Jones and Bartlett, Sudbury, MA, 2006, pp. 6–14.

- Check **Breathing**, assess the respiratory rate, and listen to lung sounds.
- Check **Circulation** including pulse rate and pulse oximetry.
- Look for and control any life-threatening **hemorrhage**.
- Assess skin for signs of adequate perfusion (e.g., color, temperature, condition, and capillary refill).
- Identify any life threatening situation/s, such as severe airway compromise and inadequate chest wall expansion.

Focused History and Physical Exam of Children

In unstable patients, this is performed as time allows once life-threatening situations have been stabilized. It is a hands-on evaluation. In younger children this can be performed in a toe-to-head fashion. Going from toe-to-head may be less threatening to children. In unconscious or older children it can be a head-to-toe assessment.

This exam should be completed after the aircraft is en route to the receiving facility. It consists of the following steps:

- Examine the head for signs of trauma. Check the fontanel in children under 2 years old. Is it open, abnormal, depressed, or bulging?
- Examine the face. Check pupil size, symmetry, and reaction to light.
- Check the neck; note any stiffness.
- Check the chest, noting stridor, retractions, or increased respiratory effort.
- Listen to the chest, checking for the quality of breath sounds, (rales or wheezes) and note any differences between the right and left chest. Lung sounds may be difficult to hear in an aircraft once the engine/s is/are running.
- Check the abdomen for distention, rigidity, bruising, and tenderness.

- Check all extremities for pulses, signs of trauma, muscle tone, symmetry of movement, and sensory function.
- Examine the skin color, temperature, and capillary refill.

Special Notes on Pediatric Patients

It is important for the air medical escort to consider the following things when treating pediatric patients:

- **Airway management is the highest priority**, since respiratory failure is frequently the cause of cardiac arrest in children.
- Do not hyperextend or hyperflex a child's neck when opening and maintaining his or her airway.
- **Treat for shock early.** Children compensate for shock well, then suddenly decompensate.
- Reassess children every 5–15 minutes.
- Do not constrict a child's abdomen; it may compromise breathing.
- Be alert for indications of child abuse, neglect, or sexual assault.
- Consider a child's developmental age when performing an assessment.

General Packaging

Many potential problems can be prevented if an air transport crew anticipates them and performs interventions before loading patients onto aircraft. Most patients transported by air ambulance should have the following:

- **IV access**—this can be used to give the patient fluids, or as a route for medications. Since starting an IV line (or two) may be more difficult to perform during an emergency or on the aircraft, IVs should be started as part of patient preparation.

- **Administration of humidified oxygen**—altitude changes and the stresses of flight can greatly increase oxygen demand. Routine administration of oxygen reduces the effects of these stresses and can prevent hypoxia. Humidification is most important in flights lasting over 30 minutes.

- **Vital sign monitoring**—air travel may stress the cardiovascular system. Oxygen saturation frequently drops during transport. Routine monitoring of vital signs, including pulse oximetry, is recommended.

- **Cardiac rhythm monitoring**—use of cardiac monitoring can identify problems early.

Situation-Specific Considerations When Preparing a Patient for Air Medical Transportation

Patients with conditions listed below may require special positioning during flight. These include:

- **Unstable cardiac patients**—it is useful to attach hands-free defibrillation pads to the patient's chest prior to flight.

- **Pregnant patients** ideally should be placed in the left lateral recumbent position. On long flights the patient may roll from side to side. Supine positioning can cause hypotension in the pregnant patient. Some services recommend positioning the pregnant patient with her head aft (towards the back of the aircraft).

- **Patients with head injuries** should be positioned with the head forward for takeoff. This can lessen G-forces transmitted to the head during take-off and potentially help prevent an increase in intracranial pressure (ICP).

- **Stable pediatric patients** should be positioned near their parents or caregivers.

- **Patients with splints** should be positioned so circulation, sensation, and movement (CSM) checks can be performed during flight.

Medical Conditions that are Sensitive to Changes in Air Pressure

Conditions with air trapped inside a body cavity are best transported with sea-level cabin pressurization. As the trapped air expands, pressure may be put on organs. This can cause the patient's condition to worsen.

The following is a list of medical conditions that can cause air trapping:

- Pneumothorax
- Bowel Obstruction
- Pneumocephalus
- Sinusitis
- Mediastinal Emphysema
- Subcutaneous Emphysema

Patients with the medical problems listed below are also best transported at or near sea-level pressurization:

- Pulmonary hypertension
- Diving injuries
- Sickle cell disorders
- Severe hypoxia despite high concentrations of supplemental oxygen

Specific Medical and Trauma Situations

Head Injuries

1. Closed Head Injuries and Increased Intracranial Pressure

Each year in the United States, traumatic brain injury (TBI) is the cause of approximately 52,000 deaths.[2] In Alaska, there are over 500 TBIs each year that result in death or hospital admission.[3] Care of patients with TBI includes prevention of hypotension and hypoxia. Hypotension is associated with a 150% increase in mortality in patients with TBI.[4] Hypoxia in head-injured patients also has been linked to poor patient outcome.

Hypotension in general, and Mean Arterial Pressure (MAP) in particular, directly affects cerebral perfusion pressure. When blood pressure falls and/or intracranial pressure rises, brain perfusion and cerebral blood flow are decreased. This relationship is described with the formula below:

Mean Arterial Pressure – Intracranial Pressure = Cerebral Perfusion Pressure (CPP)
(MAP) (ICP)

Although air medical crews are generally not able to directly measure CPP or ICP during transport, the patient's MAP should be maintained at 90 mm Hg or above. Monitoring MAP and keeping it above 90 mmHg is the best tool available for the air medical escort to ensure CPP is adequate.[5]

In a 1996 study examining hypoxia and hypotension in head injured patients, 49 consecutive patients had their presenting oxygen saturation and outcome measured.[6] The results are shown in the table below:

Arterial Saturation	Under 60%	60–90%	Over 90%
Died	3 (50%)	6 (27%)	3 (14%)
Severe Disability	3 (50%)	6 (27%)	1 (5%)
Recovery—Moderate Disablity	0	10 (46%)	17 (81%)
Total	6 (100%)	22 (100%)	21 (100%)

[2]E. J. Gabriel, J. Ghajar, A. Jagoda, et al., *Guidelines for Prehospital Management of Traumatic Brain Injury,* Brain Trauma Foundation, New York, 2000, p. 117.

[3]Alaska Bureau of Vital Statistics and Alaska Trauma Registry 1996–1999.

[4]R. M. Chesnut, L. F. Marshall, M. R. Klauber, et al., "The Role of Secondary Brain Injury in Determining Outcome from Severe Head Injury," *Journal of Trauma* 34, 1993, pp. 216–222.

[5]Renee Semonin Holleran, *Air & Surface Patient Transport: Principles & Practice*, 3rd ed., Air and Surface Transport Nurses Association (ASTNA), Mosby, St. Louis, 2003, p. 269.

[6]N. Stocchetti, A. Furlan and F. Volta, "Hypoxemia and Arterial Hypotension at the Accident Scene in Head Injury," *Journal of Trauma* 40, 1996, pp. 764–767.

The Brain Trauma Foundation recommends that patients with traumatic brain injuries be maintained at an oxygen saturation of at least 90%. They further recommend that intubation be performed in those patients with TBI and a Glasgow Coma Scale (GCS) score of less than 9, or those who can't maintain their airway, or who are hypoxic despite oxygenation.

Basic Life Support (BLS) Interventions

- If breathing is adequate, administer high flow (100%) oxygen by non-rebreather (or blow-by in children) as tolerated.
- If breathing is not adequate, ventilate with 100% oxygen at normal rates to maintain O_2 saturation of 90% or better.
    - Adult rate: 10–12 breaths per minute.
    - Child (1–8 years of age) rate: 12–16 breaths per minute.
    - Infant rate: 16–20 breaths per minute.
- Hyperventilate the patient **only** if the following conditions exist:
    - GCS score is less than 9 and decreases by 2 or more points; or
    - One or more of the following signs of brain herniation are present:
        - ♦ Asymmetric, dilated, or non-reactive pupils.
        - ♦ The patient presents with abnormal flexion or abnormal extension (neurologic posturing).
        - ♦ Hypertension and bradycardia in conjunction with an altered mental status.
        - ♦ Abnormal breathing pattern.

Approximate Hyperventilation Rates[7] for Patients with TBI and Signs of Brain Herniation	
Adult Patient	20 breaths/minute
Child (age 1–8)	30 breaths/minute
Infant	30–45 breaths/minute

[7]E. J. Gabriel, J. Ghajar, A. Jagoda, et al. "Brain-Targeted Therapy" in *Guidelines for Prehospital Management of Traumatic Brain Injury*, Brain Trauma Foundation, New York, 2000, p. 159.

- If it is not contraindicated, elevate the head of the bed 15 to 20 degrees. If the patient is in spinal immobilization, head of the stretcher should be elevated if possible.
- Position patients with head injuries with their heads to the front of aircraft, when possible, to minimize the effects of G-forces on take-off. Talk with the pilot about longer take-off and landing rollout to decrease the G-forces.
- Request that aircraft fly at the lowest safe altitude or maintain a low cabin altitude.
- If a patient has a traumatic brain injury and a history of seizures it is helpful to:
    - Keep the patient calm.
    - Ensure adequate oxygenation, monitor oxygen saturation if possible.
    - Try to reduce seizure-causing stimuli, including:
        - Anxiety.
        - Hypoxia.
        - Hyperventilation.
        - Flicker vertigo (spatial disorientation including flashing wing strobe lights, snow flying past the window, propeller movement, etc.).
    - Be ready for seizures:
        - Have suction ready for use.
        - Prevent the patient from injuring themselves further if a seizure occurs.

Advanced Life Support Skills (ALS) Interventions

- Maintain oxygen saturation above 90 percent. Consider early intubation to reduce the risk of aspiration and help manage intracranial pressure (ICP). Use of rapid sequence intubation techniques may be beneficial when attempting to intubate patients with head injuries. Try to minimize increases in ICP when attempting intubation.

- Maintain systolic blood pressure above 90 mm Hg. Hypotension is associated with poor patient outcome. Avoid fluid overload, as excess fluid administration may be associated with increases in ICP.

- Consider using preventative sedation if a patient with a head injury has a history of recent seizures.

- Nasogastric (NG) tubes should be used with caution in patients in spinal immobilization or who are unconscious after a head injury. The risk of insertion of an NG tube, especially in a patient with a possible basilar skull fracture, should be weighed against the benefit of decompressing the stomach and possibly preventing vomiting, which can increase ICP and compromise the airway.

- Monitor end-tidal CO_2 to prevent excessive ventilations. CO_2 levels should be kept between 25–30 mm Hg in patients with increased ICP. Avoid levels below 25 mm Hg.

2. Head Injuries with Gas Entrapment

According to Holleran, about 3% of skull fractures result in pneumocephalus. Pneumocephalus is defined as air within the cranial vault. This occurs most frequently when the fracture occurs in the bones separating the sinuses and ears from the brain (frontal, ethmoid, sphenoid sinuses, or the mastoid process). Fractures in these areas allow the entry of air into the skull. Pneumocephalus also is associated with brain tumors or gas-filled cysts.

If the air in the skull is trapped by blood clots or swelling, it can expand when the patient is taken to altitude (Boyle's Law). The rigid skull prevents a change in overall volume. As the trapped air expands, the pressure increases on the brain. Brain tissue is soft and is susceptible to the effects of increased pressure. Signs and symptoms of pneumocephalus are dependant on the location and the volume of air present within the skull.

BLS Interventions

- A pressurized aircraft is the best choice for transporting patients with pneumocephalus. Keep the cabin altitude as low as possible; sea level cabin pressure is preferred.

- In unpressurized aircraft, ask the pilot to fly at the lowest safe altitude.

- If pneumocephalus is suspected, consider getting skull x-rays or a CT scan before flight. It may reveal trapped gas and could also be compared with films taken after the flight to determine if changes have occurred.

- Monitor neurological status, including GCS, closely.

ALS Interventions

ALS interventions are the same as those for BLS.

3. Facial Injuries

The first concern when treating patients with facial injuries is to maintain a clear airway. Blood, mucus, broken teeth or dentures, fractures, and foreign bodies may contribute to an obstructed airway.

After the airway has been cleared, it is important to provide adequate ventilations. Air medical escorts must secure a reliable airway before flight. This may include use of:

- A Combi-Tube®.

- Endotracheal intubation.

- A surgical airway (cricothyrotomy).

Some patients with mandibular fractures are treated by wiring the jaw in position. Mandibular wiring should have a quick release mechanism to allow the jaw to be opened if the patient vomits. If a quick release mechanism was not used, the air medical escort must bring equipment (e.g. wire cutters) to help remove the wires in case of vomiting. This is not ideal as the vomit may obscure the wires before they can be removed.[8]

Cervical spine injury should be suspected in patients with facial injuries, until proven otherwise.

BLS Interventions

- Transport patients with mandibular wiring in the position of comfort if their injuries permit.

- Have suction ready.

- If jaw fixation is released (e.g. if the patient has vomited), secure the mandible by wrapping the patient's head and lower jaw with an ace bandage.

[8]Genell Lee, *Flight Nursing Principles and Practice*, National Flight Nurses Association, Mosby, St. Louis, 1991.

- Agree on signals beforehand or bring a clipboard for written messages when verbal communication is hampered by the patient's injuries.

- Do not give food or fluids by mouth.

ALS Interventions

ALS interventions are the same as those for BLS.

4. Eye Injuries

Normally the eye is filled with liquid, which is not affected by barometric pressure changes. Patients who have had recent eye trauma or eye surgery, however, may have air trapped within their eye or eyes. In these cases, a lower cabin altitude must be maintained to prevent the changes in pressure from reopening the wound or separating the surgical incision.

Hypoxia is a concern for patients eye injuries. The retina requires more oxygen than any other body tissue. Oxygen should be administered at cabin altitudes above 4,000 feet in patients with eye injuries.[9]

The combined effects of visual disturbance, motion, and fear increase the possibility of nausea. Vomiting increases intraocular pressure. Preflight medication to reduce the likelihood of vomiting should be considered in patients with a history of motion sickness.

BLS Interventions

- Do not squeeze or put pressure on the globe of the eye if there is a penetrating eye wound.

- Do not use eye ointments in patients with eye injuries, unless specifically directed to by a physician.

- Cover eyes that have been injured by heat, chemicals, or ultraviolet radiation with a dry dressing. When using an eye patch during transport, cover both eyes to prevent involuntary movement of the injured eye.

- Air medical transports can be frightening for patients, especially if the patient cannot see or has both eyes patched. Talking with the patient, explaining things in detail, and/or maintaining physical contact may be reassuring for these patients.

[9]Chapter 16, "Aeromedical Evacuation Medical Conditions Requiring Special Management," *United States Naval Flight Surgeon's Manual*, Third Edition, 1991.

- In case of chemical burns to the eye, ensure that the patient's eyes have been flushed with normal saline for at least 15 minutes. If this has not already been done, it is better to remain on scene or at the sending facility and flush the eyes, than to move the patient to the aircraft and delay eye irrigation longer.

ALS Interventions

- Consider sedation to help control pain and apprehension. Avoid using opiates (e.g. morphine, Demerol®) as they cause pupillary constriction.

- Consider using a preflight anti-emetic medication.

5. Ear And Throat Problems

The effects of atmospheric pressure changes on the ears are discussed in Chapter 5. Equalization of pressure in the ears is more difficult on descent. During ascent, heightened internal pressure helps to open the eustachian tube. During descent, decreased pressure in the middle ear may force the eustachian tube closed. This pressure difference can cause pain and, in rare instances, rupture of the eardrum.

The greatest changes in barometric pressure per 1,000 feet occur below 15,000 feet. For this reason it is more important to clear ears frequently when descending rapidly while at low altitudes. Patients may need coaching to clear their ears. If patients are unable to clear their ears, air medical escorts can ask the pilot to re-ascend to a comfortable level, and then make a more gradual descent. The patient should try to clear his or her ears frequently during the more gradual descent.

Respiratory infection is a common reason for ear-clearing difficulties. Inflammation of sinuses, sore throats, and/or middle ear infections can cause swelling of the eustachian tube. Forceful opening of the eustachian tube can allow infected material into the middle ear.

Breathing 100% oxygen during flight can predispose a patient to a delayed ear block, which can form several hours after landing. Excess oxygen reabsorbs over time. Performing the Valsalva maneuver (blowing against a plugged nose with the mouth closed) can help reduce the pressure from delayed ear block.

BLS Interventions

- Coach patients to use ascent ear clearing techniques such as side-to-side jaw rocking and forceful swallowing. These techniques create suction in the throat, which can pull pressure out of the ear through the eustachian tube.

- Coach patients to use descent ear clearing techniques such as yawning, swallowing, tensing throat muscles, and Valsalva maneuver.

- Try to avoid flying patients who have had middle ear surgery until their middle ears are dry and well aerated. If flight is necessary, a pressurized aircraft with a low or sea-level cabin altitude is best.

ALS Interventions

Medications that reduce inflammation of nasal and sinus tissue may help prevent ear and throat problems during flight in patients with upper respiratory tract infections, sinus congestion, or allergies. If given, they should be administered prior to departure. These medications include:

Phenylephrine nasal inhaler preparations such as Afrin® or Neosynephrine®.

Oral decongestants such as Actified® or Sudafed®.

6. Nasal Problems

The sinuses create a gas-trapping situation similar to that of the middle ear. The sinuses are relatively rigid, air-filled, bony cavities lined with mucous membrane. They connect with the nasal passages by means of one or more small openings:

- There are two sinuses located within the bones of the forehead (frontal).

- There is one sinus in each cheekbone (maxillary).

- There are also four sinuses in the bones behind the base of the nose (two each in the ethmoid and sphenoid bones).

When inflammation or obstruction is present, gas can be trapped in the sinuses. This occurs most frequently in the frontal sinuses. Maxillary sinuses can also be affected. As with barotitis, symptoms of barosinusitis are most commonly seen during descent. Generally pain is the result of gas trapped in the sinuses, although maxillary sinusitis can be mistaken for an upper jaw toothache and can cause bleeding.

BLS Interventions

- Treat patients with sinus pain early, when the pain is first noticed. It is best to return to the altitude at which the block

occurred and have the patient try to relieve sinus pressure with the Valsalva maneuver.

- Use humidified oxygen to prevent nosebleeds (epistaxis). Nasal saline spray may be helpful.

- Treat epistaxis by having patients sit up, encouraging mouth breathing, and applying firm pressure at, or slightly under, the bony portion of the nose. Six or seven minutes of uninterrupted pressure should stop the bleeding. Have patients spit out blood that collects in their mouths. Swallowing blood irritates the stomach and could cause vomiting.

ALS Interventions

- Consider administering a nasal decongestant spray (e.g., Afrin®or Neosynephrine®) or oral decongestant (e.g., Actified®, Sudafed®) prior to departure for patients with sinus congestion. Prevention of barosinusitis is more effective than treatment.

- If a block develops during descent, consider using a nasal decongestant spray after returning to the altitude at which the block began.

- Packing the anterior nasal cavity with gauze may help control severe nosebleeds. External pressure should be reapplied after packing. Spraying Afrin® into the nose shrinks blood vessels and may stop bleeding that does not respond to direct pressure alone.

7. Problems with the Teeth

Pressure induced toothache (barodontalgia) is generally found in people who have pre-existing dental disease, though the patient may not have symptoms at sea level. It is common for pain to begin on ascent, with descent bringing relief.[10] Pain usually develops between the altitudes of 5,000 to 15,000 feet.

BLS Interventions

Ask the pilot to descend to the altitude at which the pain first developed. Descent may provide pain relief.

ALS Interventions

ALS interventions are the same as those for BLS.

[10]R. S. Holleran, *Air & Surface Patient Transport: Principles & Practice,* 3rd edition, Air and Surface Transport Nurses Association (ASTNA), Mosby, St. Louis, 2003, p. 50.

Neck And Spinal Cord Trauma

Treatment priorities for patients with neck and back injuries are the same in the air medical environment as they are on land: airway, breathing, circulation and careful immobilization. The need to protect the spine effectively has to be balanced with minimizing the time a patient spends strapped to a hard spine board.

Patients who spend too much time lying on a backboard are prone to skin breakdown, which can lead to other complications that may lengthen the hospital stay. A vacuum mattress or padding the backboard carefully can minimize these effects.

Patients with known or suspected spinal cord trauma must be immobilized for air transportation. Acceleration/deceleration forces, turbulence, loading, and unloading can cause movement that may worsen a patient's spinal cord injury if he/she is not securely immobilized. This means not only securing the patient to the backboard, but also securing the backboard to the airframe so that it does not shift in flight. The attachment between the airframe and the backboard should have a quick-release mechanism to allow the air medical crew to roll the patient if vomiting occurs.

Cranial tongs with traction weights do not perform satisfactorily in flight. Acceleration forces cause the traction applied to vary during flight. If traction is needed during flight, a fixed-traction or constant-tension spring (Collins spring) should be applied prior to flight.

Receiving hospitals should evaluate backboarded air transport patients quickly, and move them off rigid spine boards as soon as it is safe.

BLS Interventions

- Pad long backboards; consider use of vacuum mattresses for comfort.
- Consider tilting the board during longer flights to change pressure points on the patient's body.
- Patients on backboards may have difficulty in clearing their airways; always have a large-bore suction device ready in case vomiting occurs.

ALS Interventions

- Consider using preflight anti-emetic medications.

- Administer a high dose methlyprednisolone within the first eight hours of the injury if the patient has a non-penetrating spinal cord injury. The dose of methlyprednisolone is 30 mg/kg within the first 15 minutes, followed by a 5.4 mg/kg per hour IV infusion for the next 23 hours.[11]

- Intubate patients with high cervical spine injuries prior to transport; this is especially important if there is any concern that they may develop partial or total loss of respiratory function.

Chest Trauma And Respiratory Problems

Chest Trauma

Fatal chest injuries most often involve internal bleeding (hemothorax), air in the pleural cavity (pneumothorax), or a flail rib section. These patients must be stabilized before flying, as their problems can worsen or reoccur during flight.

General Chest Trauma

When evaluating and/or treating patients with chest trauma, air medical escorts should:

- Thoroughly assess the lungs before transporting. This should be done in a quiet environment (before the patient is placed in noisy aircraft) if at all possible.

- Monitor the patient closely. Signs of respiratory distress can include:

  - Increased rate and depth of breathing.

  - Shortness of breath.

  - Decreasing oxygen saturation.

  - Cyanosis.

  - Asymmetrical chest rise.

  - Worsening end tidal carbon dioxide ($EtCO_2$).

- Watch for signs of tension pneumothorax (defined later in Specific Chest Injuries), including:

  - Shallow, labored breathing.

[11]American College of Surgeons, *Advanced Trauma Life Support for Doctors: Student Course Manual*, 1997, p. 229.

- Tracheal deviation away from side of the injury.
- Distended neck veins.
- Asymmetrical or no chest rise.
- Shock.
- Cyanosis.
- Respiratory and/or cardiovascular arrest.

BLS Interventions

- Ask the pilot to fly at the lowest safe altitude or pressurize the cabin to as close to sea level as is safe.
- If spinal immobilization:
  - Is not required, let the patient assume a position of comfort.
  - Is required, elevating the head of the stretcher may help the patient's breathing.
- Provide oxygen.

ALS Interventions

- If a chest tube is used, secure it well. Check that a Heimlich valve has been attached.
- If signs of increased pressure in the chest are evident, release the pressure by briefly loosening or removing the dressing over the hole in the chest to allow air to escape. Reseal it afterwards. Penetrating chest wounds should be sealed on either three or four sides with an occlusive dressing. Monitor patients closely for the return of a tension pneumothorax after releasing pressure from the wound site.
- Patients with flail chest may benefit from intubation and positive pressure ventilation.

Specific Chest Injuries

1. Hemothorax

Hemothorax occurs when blood collects in the pleural space. These

patients should receive aggressive shock management including fluid boluses and possibly blood products. High flow oxygen should be given to all patients with hemothorax. If breathing is inadequate, secure the airway and support respirations. Chest tube placement may be necessary. These patients need prompt evaluation by a trauma surgeon.

2. Pneumothorax

A pneumothorax occurs when air enters the pleural space. Boyle's Law states that an increase in altitude causes gas expansion. Therefore, what was a small, asymptomatic pneumothorax at sea level can become a large, symptomatic pneumothorax or tension pneumothorax at altitude.

Chest tubes allow air to escape from the chest cavity and prevent pressure from building up in the chest. A Heimlich value can prevent the chest tube from acting as an open chest wound should the tubing become disconnected. It may be best to transport a patient with a pneumothorax by ground, if possible. If a patient has a pneumothorax, a chest tube must be in place, or the air medical team transporting the patient must be capable of performing needle compression before that patient is placed in an aircraft.

3. Tension Pneumothorax

Tension pneumothorax occurs when the organs inside the chest cavity are compressed due to the build-up of pressure in the pleural space. It is an immediate life-threatening situation. Typically it presents with rapid deterioration of both respiratory and cardiovascular function. The most common emergency technique to relieve a tension pneumothorax is the insertion of a large-bore (14-gauge) IV catheter into the second intercostal space (above the third rib) at the mid-clavicular line. Only medical providers who are trained in this technique should attempt to perform needle chest decompression. Needle decompression relieves excess pressure. A one-way valve can be applied to the needle after the pressure is released. Following the steps below can make a one-way valve:

1. Insert IV tubing into the angiocatheter.
2. Cut the drip chamber (at the far end) in half.
3. Insert a Heimlich valve into the drip chamber.

4. Mediastinal Emphysema

Mediastinal emphysema occurs when air enters the mediastinum. At altitude air in this space will expand and may cause possible respiratory compromise. It's best to use pressurized aircraft or fly at the lowest safe altitude when transporting patients with mediastinal emphysema as well as pneumothorax.

5. Flail Chest

Flail chest occurs when two or more ribs are fractured in more than one place. This allows a segment of the chest to move independently from the rest of the chest wall. Complications that can result from a flail chest include:

- Difficulty breathing.
- Pneumothorax.
- Hemothorax.

Respiratory Conditions

1. Pneumonia

Patients with pneumonia are more prone to hypoxia during air medical evacuations. This is due to decreased gas exchange in the infected areas in the lungs as well as the lower atmospheric pressure at altitude. The more serious the pneumonia, the worse the hypoxia is at altitude. For reasons not clearly understood, preexisting pneumonia seems to progress rapidly (gets worse quickly) after air medical evacuation.

2. Respiratory Failure

Patients in severe respiratory failure or arrest can be evacuated by air if the air medical team is proficient in bag-valve-mask ventilation. Endotracheal intubation provides a definitive airway. When ventilating a patient who is not intubated, two-rescuer ventilation is generally preferred. One person ventilates (squeezes the bag-valve-mask) while the other person maintains the airway with positioning and ensures a good mask seal.

BLS Interventions

- If a patient has serious respiratory compromise at ground level, they are likely to worsen at altitude. If a choice exists, a

pressurized aircraft is preferred for these patients.

- Use high-flow, humidified oxygen.
- Monitor oxygen saturation and end-tidal carbon dioxide levels ($EtCO_2$).
- Let the patient assume a position of comfort, when possible.
- Have suction equipment ready.
- Check to ensure that essential items are available for respiratory management.
- Bring enough oxygen, not only for the flight, but also plan for some ground delays.

ALS Interventions

- Bronchodilators may be helpful for some patients. If used, it may be beneficial to give the first dose prior to flight.
- If there is a possibility that intubation will be needed, it is best to do so before the flight. Check with guidelines or protocols for individual recommendations.
- Positive end expiratory pressure (PEEP) may benefit patients with acute pulmonary edema.
- Other medications (e.g., diuretics, morphine, and other cardiovascular medications) can be given to manage patients with acute pulmonary edema.

3. Hyperventilation

There are medical and emotional causes for hyperventilation. It is vital that the air medical escort rule out medical causes for hyperventilation before assuming that a patient with an increased respiratory rate is anxious. It is easy to mistake hyperventilation due to a serious underlying imbalance (protective hyperventilation) for the anxiety-induced type (hyperventilation syndrome). Both have the same name in common language. Both types of hyperventilation lower blood carbon dioxide levels (hypocapnia). Hyperventilation's physiologic effects are substantial and may include:

- Tingling of lips and hands.

- Spasms of the hands and fingers.
- Chest tightness.
- Dizziness.
- Unconsciousness.

Protective Hyperventilation

Protective hyperventilation acts as a defense against hypoxia, acidosis (increased acidity to the blood), and hypercapnia (high carbon dioxide levels in the blood). Patients with the following conditions may have protective hyperventilation:

- Heart attack.
- Hypovolemic shock.
- Pulmonary edema.
- Diabetic ketoacidosis.
- Aspirin overdose.
- Acute episodes of emphysema.
- Asthma.

Patients with one of the conditions listed above hyperventilate because their bodies need to take in more oxygen, lower the carbon dioxide level, or both. Symptoms in these patients are more likely to reflect the underlying problem than the physiologic effects of hyperventilation. Therefore, the best approach is to:

- Monitor the patient for hypoxia.
- Watch for signs of shock.
- Evaluate for unusual breath odor.
- Be sure to ask about pertinent medical conditions. If there is any reason to suspect hypoxia, acidosis, or hypercapnia from the history or exam, assume the patient is hyperventilating for a medical reason and proceed to treat the underlying cause.

BLS Interventions

- Perform a thorough history and physical exam of the patient.
- Monitor the patient's vital signs.

ALS Interventions

- Monitor the patient's cardiac rhythm.
- Treat any identified underlying causes of hyperventilation (e.g., heart attack, hypovolemic shock, etc.).
- Follow ACLS protocols.

Hyperventilation Syndrome

Hyperventilation syndrome, on the other hand, may be due to anxiety or fear. Air transport can worsen this anxiety and increase the rate of breathing. It also inappropriately overrides the carbon dioxide-sensing respiratory drive that normally depresses breathing as carbon dioxide levels in the body fall. The treatment for this type of hyperventilation revolves around coaching patients to slow their breathing rate.

BLS Interventions

- Coax the patient's attention away from the problem and suggest strategies to focus on the solution.
- Ask the patient to hold each inhalation briefly, and then count to 10 slowly while exhaling.
- Keep communicating throughout the flight. When coaching breathing, air medical escorts may want to keep their faces close to the patients' faces and breathe in unison with them.
- Encourage patients to keep their eyes open to stay focused on breathing with the air medical escort.
- Encourage talking or singing. Both require a degree of breath control.

ALS Interventions

ALS interventions are the same as those for BLS.

4. Ventilated Patients

Using ventilators on patients being transported by air can present the following challenges:

- Ventilators do not allow escorts to feel lung compliance.
- Gas expands as the altitude increases. This can result in an increase in the tidal volumes delivered, which can lead to barotrauma. The risk of this happening can be reduced by:
  - Observing for normal chest rise and fall.
  - Observing peak pressure on inspiration.
  - Setting ventilators on lower tidal volume (e.g. 10 ml/kg) initially until the aircraft is at cruising altitude.

Ventilators should be used with caution with trauma patients. Oxygen should be humidified for ventilated patients. This can be done with an in-line humidifier designed for use in the intubated patient.

5. Botulism

Foodborne botulism continues to be a problem in Alaska. There were 250 cases of confirmed botulism in Alaska from 1950–2003.[12] "All cases (of botulism) in Alaska have been associated with the preparation and storage of traditional Alaska Native foods."[13]

Botulism toxin affects the neurologic and muscular systems. Signs and symptoms are consistent with muscle and nerve dysfunction and can include gastrointestinal and urinary effects. Fever is usually not present with botulism. It is important to remember that signs of respiratory distress (e.g. restlessness, gasping, vigorous chest movement, and use of accessory muscles) may be decreased or absent due to muscle weakness associated with botulism. Respiratory arrest may be sudden and occur with little warning. It is vital to monitor respiratory function and observe closely.

If patients with suspected botulism need to be transported by air, consider placement of an endotracheal tube prior to transfer.

Suspected cases of botulism must be reported to the Department of Health and Social Services, Section of Epidemiology immediately so that associated cases can be found quickly and to prevent additional

[12] *Botulism in Alaska: A Guide for Physicians and Health Care Providers—2003 Update*, Section of Epidemiology, Department of Health and Social Services, State of Alaska, Anchorage, (in publication).

[13] M. Beller, (ed.) *Botulism in Alaska: A Guide for Physicians and Health Care Providers—1998 Update,* Department of Health and Social Services, State of Alaska, Anchorage, p. 4.

people from eating suspect food. The 24-hour emergency reporting number for Epidemiology is (800) 478-0084.

Treatment of botulism includes IV infusion of antitoxin after blood samples have been obtained. *Botulism in Alaska: A Guide for Physicians and Health Care Providers* also recommends:

- Placement of an NG tube to decompress the stomach.
- High colonic enemas may remove any retained colonic contents which may have toxin.
- A Foley catheter can be useful if the patient has urinary retention.

Patients with botulism tend to have thick, tenacious secretions. While humidified oxygen is important for all patients who are intubated during air medical transports, it is even more important for a patient with botulism.

Cardiac Disease

Organs must have oxygen to function normally. In healthy people, the heart can deliver more oxygen than the body needs. Cardiovascular diseases reduce the heart's ability to deliver enough oxygen to meet the body's demands. Cardiopulmonary stresses in flight can be significant in the patient with a healthy heart. These stresses can be disastrous for patients with coronary disease, even if the patient is asymptomatic at ground level.

- Hypoxia poses the greatest risk for cardiac patients.
- The psychological stress of being transported by air increases adrenaline levels, which stresses the heart.

It is important to match the air medical escort's scope of practice with the immediate and potential needs of a cardiac patient, especially if medication administration is likely.

BLS Interventions

- Encourage patients to relax and rest. Do not let them walk unassisted.
- Administer oxygen.

- Perform a thorough assessment prior to transportation. It is difficult to hear chest sounds during flight. Assessment of the cardiac patient should include looking for neck vein distention, capillary refill time, and quality of pulses in the extremities.

- Transport cardiac patients in the position of comfort if they are not in shock. It may be necessary to bring extra pillows or blankets to help prop the patient up into a comfortable position.

ALS Interventions

Establish IV access before the flight.

- Initiate cardiac monitoring for rhythm disturbances.

- Follow ACLS Guidelines, as permitted by local protocols and the scope of practice for the air medical escort.

CPR

To provide optimal chest compressions during CPR, it is best if there is forty-two inches clearance above the patient's chest. Frequently this is not possible in smaller aircraft. Medical escorts should take great care to keep their shoulders over the patients' chests as to prevent giving sideways chest compressions. Improper chest compressions cause broken ribs and patients' blood does not circulate effectively.

If a patient goes into cardiopulmonary arrest, escorts need to:

- Begin CPR and follow standing orders for resuscitation.

- Notify the pilot(s) immediately. This is the ultimate in-flight emergency and warrants diverting the aircraft to the nearest ground location with advanced resuscitation capabilities. Receiving personnel, including ground transportation, should be told that the patient is in cardiac arrest.

- EMTs, Paramedics (MICPs) and Physician Assistants (PAs) may pronounce death in the field under AS 18.08.089. This statute requires that the EMT, Paramedic, or PA be an active member of a certified EMS service, that an attempt is made to contact a physician, and that the person has sustained irreversible cessation of heart and lung function. Air medical escorts should be familiar with the provisions of this statute.

- Under Alaska Statute 08.68.395, a registered nurse who has determined and pronounced the death of a patient shall

document the clinical criteria for the determination and pronouncement in the person's medical or clinical record and notify the physician who determined that the prognosis for the patient was for an anticipated death.

- If CPR is halted and the patient is pronounced dead, the air medical crew must note the exact time they stopped CPR. They should tell the pilot(s) so that the navigational coordinates can be recorded. The FAA investigates every death that occurs during flight in U.S. airspace, including those on air medical flights.

- If the patient's condition is such that they may require defibrillation during flight, the medical escort can prepare by:

    - Placing the patient on a stretcher that is made from something other than metal, if possible. If a metal litter is all that is available, provide enough insulation between the patient and the litter so that no part of the patient's body is in direct contact with the metal.

    - Positioning the patients' limbs alongside their bodies and away from the shell of the aircraft.

    - Warning the pilot before they defibrillate the patient. The pilot(s) should understand the air medical escorts' use of the word, "clear."

    - Using defibrillation pads, rather than gel, because they lessen the chance of arcing. It is highly recommended that hands-free defibrillation pads be used for codes in flight. This reduces the risk of the rescuer shocking themselves by accidental contact with the stretcher due to the confined space inside smaller aircraft. Consider placing these pads in advance on all patients who are at high risk for cardiac arrest.

Gastrointestinal Disorders

The stomach and intestines normally contain gas at a pressure approximately equal to that of the surrounding atmosphere. The majority of gas resides in the stomach and large intestine. It results from swallowed air and the chemistry of digestion. Gastrointestinal (GI) pain from trapped gas is a result of:

- The volume and location of the gas.

- The sensitivity or irritability of the intestine.

Usually GI pain is not serious for healthy individuals flying at low or intermediate altitudes. However, high altitude and/or abnormal intestinal sensitivity can create problems. Gas pains of even moderate severity can lower blood pressure through vagal stimulation. Loss of consciousness can occur (rarely) if belching or passing gas does not relieve the distention. For this reason, any individual experiencing gas pain should be watched closely for changes in mental status. If a patient experiences a sudden increase in abdominal pain, or has sudden onset of hypotension, or a change in mental status that appears to be secondary to GI distention, have the pilot descend to the lowest safe altitude until the symptoms subside. Patients with known GI gas trapping (e.g. volvulus, intestinal obstruction, etc.) are best transported in a pressurized aircraft with low/sea level cabin pressurization.

BLS Interventions

- Use of pressurized aircraft with a low or sea level cabin pressurization is beneficial for patients with bowel obstruction.

- Warn patients with colostomies that colostomy output increases at altitude. Empty the colostomy bag just prior to flight. Bring supplies to either empty or change the colostomy bag should the need arise during transport.

- Place several layers of disposable absorbent pads under patients with diarrhea on transport flights. The top layers can be removed more easily during flight than changing sheets if they become soiled. Double bag soiled pads to minimize odors.

ALS Interventions

A nasogastric (NG) tube can help decompress gas in the stomach and evacuate stomach contents. It should be inserted prior to loading the patient on the aircraft whenever possible, and can be attached to suction during flights. A 60 cc irrigating syringe can be used in case mechanical suction fails or is not available.

Orthopedic Injuries

The following complications can result when transporting patients with orthopedic injuries:

- Vibration increases fracture pain and can lead to increased swelling if splints are loose.

- When air splints are being used, air expansion within the splint can impair or stop circulation under the air splint. This can occur at relatively low cabin altitudes (1,500–2,000 feet). Air splints should be used only as a last option in air transport.

- When vacuum splints or vacuum mattresses are being used, the small amount of air remaining inside the splint will expand when the splint is taken to altitude. The air medical escort should monitor the splint during assent to ensure that it does not lose rigidity. If the splint becomes soft, additional air should be evacuated. A vacuum pump should be available on the aircraft when vacuum splints or mattresses are being used.

- Tissue swelling may increase. Swollen extremities inside rigid casts are at risk for reduced circulation. "Bivalving" casts before flight helps prevent casts from becoming too tight, but may not prevent compartment syndrome. Patients should not fly for 14 days after vascular surgery procedures. If flight is necessary, a window should be cut in the cast to permit observation of the injury site and to allow treatment if bleeding starts.

BLS Interventions

- Mark the location of pulses in both the injured and uninjured extremities with a pen before flight.

- Compare the circulation, sensation, and movement (CSM) in an injured extremity with non-injured ones.

- Watch for signs of compartment syndrome. Compartment syndrome occurs when swelling prevents adequate blood flow to the site of, and distal to, the injury. Often the earliest symptom is pain with passive stretch (that is, pain greater than expected when the provider moves the fingers or toes of the affected limb gently). Signs of compartment syndrome can be remembered using the five P's:

    - Pain (and pain with passive stretch).
    - Pallor.
    - Paresthesia.
    - Paralysis.
    - Pulselessness.

- Completely immobilize the joint above, the joint below, and the site of injury to prevent excessive movement during turbulence and during patient movement/positioning.

- Elevate the injured extremity above the level of the patient's heart, if possible. This is not always possible in smaller aircraft.

- Cold packs can be placed over the injury site or cast to reduce swelling. Snow in plastic bags is a good substitute if ice packs are not available. Place insulation (e.g., a washcloth or towel) between the cold pack and the injured area to prevent the skin from freezing if the patient is not splinted. Check the area under the cold packs frequently.

- Use fixed traction or Collins springs for consistent traction. Free-hanging traction weights have no place in treating orthopedic patients during flights.

- Do not allow patients with crutches to climb into and out of the aircraft, lift them into the aircraft on a stretcher or litter.

ALS Interventions

ALS escorts can use pain medications to keep patients with orthopedic injuries more comfortable. Use of medications is determined by local protocols. Inhaled analgesics (e.g. Nitronox®) should never be used in flight, as gas leaking from the mask poses a risk to the flight crew.

Amputations

Patients with amputations should be transported to a hospital with surgical capabilities quickly. Ideally, this should be within four to six hours. Reimplantation techniques have become more sophisticated and many patients have had successful reimplantation of amputated parts. Reimplantation is most effective for those patients with cleanly severed parts; patients with severe crush-type amputations may not be candidates for reimplantation. Early consultation with surgeons at a reimplantation center is vital. Success also depends on appropriate care of the amputated part.

BLS Interventions

- Wrap amputated parts in gauze moistened with normal saline.

- Place the gauze-wrapped amputated part in a sealed plastic bag to protect it from contamination.

- Keep the plastic bag in cold water or ice water. Do not let the amputated part come into direct contact with ice, as frozen cells cannot be reimplanted.

ALS Interventions

ALS escorts can use pain medications to keep patients with amputations more comfortable. Use of medications is determined by local protocols.

Urinary Catheters and Voiding During Flight

Most medevac aircraft do not have toilets onboard. Voiding during flight can create problems, even for patients who are mobile. It can be difficult to maneuver a patient onto a bedpan in small aircraft.

BLS Interventions

- Encourage patients without catheters to void before flight.
- Have a "comfort kit" with a bedpan, urinal, toilet paper, and wet wipes available during flight.

ALS Interventions

- Monitor the urine output in patients with urinary catheters (e.g. suprapubic or Foley).
- Secure the drainage system to prevent it from pulling on the catheter.
- Keep the collection bag lower than the patient to protect against back flow of urine into the bladder. Backflow of urine can cause an infection.
- Carry a container (e.g. urinal, Convenience Bag®, etc.) into which the collection bag can be emptied should it become full during flight.

Diving Injuries

Divers breathe compressed air while diving. This compressed air is either carried in tanks on their backs (scuba divers), or supplied from an air compressor at the surface, and delivered to the diver through an air hose (hookah divers). Dive injuries can happen to anyone who breathes compressed air and moves to a location with less pressure, including people who work in hyperbaric chambers. Most frequently

this is seen in divers after surfacing, but it can also be seen in aviators or astronauts who move very rapidly from sea level to high altitude.

One form of decompression sickness (DCS) is known as "the bends." It is a condition in which inert gases, usually nitrogen, form bubbles within the bloodstream and tissues. Moving to a higher elevation after diving can cause DCS or worsen an existing case. This makes flying dangerous for people who have been diving. Generally, the recommendation is to avoid flying for 24 hours after diving. This is of concern, not only in the diver who gets decompression sickness, but also in the person who has been diving, and then has a completely unrelated injury or illness (e.g. a diver gets into a motor vehicle crash while traveling home after a dive).

Frequently, patients with dive injuries are treated in a hyperbaric chamber. In Alaska, there are hyperbaric chambers in Juneau and Anchorage. If a diver in another community needs treatment in a hyperbaric chamber, they may need to be flown from their location to a chamber. In these cases, it is best to use a pressurized aircraft and maintain the cabin pressure at sea level. When a patient with a dive injury or a person who has been diving within the past 24 hours must be flown in a non-pressurized aircraft, it is important to fly at the lowest safe altitude and not fly higher than 800–1000 feet above the starting elevation.[14,15]

The nationwide resource for advice on treating decompression sickness and other dive injuries is the Diving Alert Network (DAN). DAN accepts collect calls 24 hours a day at 919-684-8111.

BLS Interventions

- Patients who have been diving within the last 24 hours and who need medical treatment should be flown in a pressurized aircraft. It is best to transport these patients in a sea level cabin, or at the lowest safe altitude.

If the patient has a dive-related injury (e.g. arterial embolism or decompression sickness), they may require transportation to a hyperbaric chamber.

- Place the patient in a supine position. Head down positioning is no longer recommended.[16]

- Administer 100% oxygen to increase the elimination of nitrogen.

[14]Paul S. Auerbach, *Wilderness Medicine: Management of Wilderness and Environmental Emergencies,* 3rd ed., Mosby, St. Louis, 1995, p. 1198.

[15]Alfred A. Bove, and Jefferson C. Davis, *Diving Medicine*, 2nd ed., W. B. Saunders, Philadelphia, 1990, p. 252.

[16]Renee Semonin Holleran, *Air & Surface Patient Transport: Principles & Practice*, 3rd ed., Air and Surface Transport Nurses Association (ASTNA), Mosby, St. Louis, 2003, p. 501.

- Protect against and treat for hypothermia as needed.
- Handle patients gently.

ALS Interventions

- ALS escorts can administer analgesics as needed.
- An IV should be started and run to maintain urine output at 1–2 ml/kg/hour.

Sickling Disorders

Sickling disorders are a group of conditions that are caused by variations in the genetic makeup of hemoglobin (Hgb). People with sickling disorders may have additional complications during air medical transport situations due to their underlying blood disease.

Red blood cells normally have a biconcave shape. If people with a sickle cell anemia do not get enough oxygen to their cells, red blood cells change from being biconcave to being crescent-shaped. Blood viscosity also increases. When red blood cells form crescents they are less pliable and are likely to cause obstructions to blood flow. This can lead to cell damage or cellular death inside organs. Dehydration and infection also can cause blood cells to change shape and cause a sickle crisis.

Evacuate patients having a sickle crisis by air only when there is no other choice.

- If a person has a history of vaso-occlusive crises, he or she should not fly over 5,906 feet (1,800 meters) unless they are on supplemental oxygen.
- Altitudes of 4,921–6,562 feet (1,500–2,000 meters) cause a vasoocclusive crisis in 20% of people with sickle C disease and sickle-thalassemia.
- Several cases of infarction in the spleen have been reported in patients with sickle C disease at altitudes as low as 4,000 feet.

BLS Interventions

- Ask pilots to fly at the lowest safe altitude and cabin altitude possible.

- Provide oxygen for all patients with a sickle disorder, even when flying at sea level or very low cabin pressures.

ALS Interventions

- Use large volumes of IV fluids when treating patients with sickle crisis.

- Use pain medications, including narcotics, when needed. Sickle cell crisis can be extremely painful.

Psychiatric Emergencies

Air medical escorts and other responders are cautioned that an overt psychiatric condition can mask more subtle underlying conditions. A thorough medical and psychiatric assessment is important for patients with a history of a psychiatric illness, as patients may have additional medical problems or have suffered a traumatic injury. For example, a patient with a history of schizophrenia who does not take his or her medication may present with confusion and agitation. The medical provider cannot just assume that agitation is due to schizophrenia, as this patient may have been injured or could have a medical problem like hypoglycemia.

The signs and symptoms of psychiatric diseases vary with the diagnosis. Many psychiatric patients are managed with several medications. Some of these medications may have severe side effects that can further complicate patient management. An example is the muscle rigidity or dystonic reaction that can be seen with phenothiazines (e.g. Haldol® or Thorazine®).

Most psychiatric patients are not violent. De-escalation and distraction techniques (e.g. focusing the patient's attention on something neutral or calming) may be sufficient to reduce anxiety and maintain the patient's comfort. However, some psychiatric patients may pose a risk in the air medical environment due to the potential for him or her to become agitated and behave unpredictably. These risks can be reduced by:

- Sedating and/or restraining a patient who has a potential for violent behavior.

- Transporting agitated psychiatric patients by air only when ground transportation is not an option, and when there are sufficient escorts to safely control the patient.

It also is helpful to control environmental stimulation that can increase agitation in combative or psychotic patients. Some things that can be done include:

- Loading and unloading patients with the engine off and/or blades not moving.
- Speaking in a calm and reassuring tone.
- Providing ear protection to decrease the noise level.
- Respecting the patient's personal space.

Often there are behavioral clues that can warn escorts of potentially violent behavior. Escorts should be alert for these clues both prior to loading the patient on the aircraft, and during the flight to increase the safety for all on board the aircraft. Some clues of impending violent or combative behavior include:

- The patient displaying an angry or defensive posture, such as sitting on the edge of the bed or seat.
- Rapid, abusive, loud, or overly animated speech patterns.
- Clenched fists, tightening of the jaw muscles, pacing, or excessive fidgeting.
- Hypersensitivity to personal space and hypervigilance.
- A history of a fear of flying or of claustrophobia.

BLS Interventions

- Patients should only be restrained with approved restraints (e.g. four-point restraints, body net, etc.). **Warning:** Use of physical restraints, particularly the "hobble/hog-tie" restraint, has been associated with sudden death in otherwise healthy patients.[17] Medical providers should **NOT** use these techniques.[18]
- Document CSM checks every 30 minutes.

ALS Interventions

- Review any medications the patient is taking and prepare for possible side effects (e.g. Benadryl® can be used to treat dystonic reactions).

- Sedate potentially violent patients following the agency protocols and standing orders (e.g. Haldol® or droperidol).

- In severe cases, the patient may need to be given sedation, paralytics, and be intubated and mechanically ventilated for the flight.

Burns

Management of patients with burns begins with the ABCs.

Airway

Patients with burns should receive high flow oxygen. This oxygen should be humidified if possible. Patients who are at risk of a compromised airway include:

- Patients with burns to their faces and/or necks.

- Patients who show signs of inhalation injury.

A definitive airway should be obtained prior to transport. Endotracheal intubation is better than cricothyroidotomy in a patient with a swollen neck. Edema can form rapidly, particularly if IV fluids are administered. Rapid sequence intubation (RSI) may be useful in burn patients, but use caution if the burn is more than a few hours old as the patient can have elevated potassium levels. Anectine® (succinylcholine) has been linked to ventricular dysrhythmias, cardiac arrest, and death in patients with burns.

Securing endotracheal tubes may require alternatives to tape if the patient also has facial burns. Some alternatives to consider using are:

- A commercially available tracheal tube holder.

- Umbilical tape.

- Stapling or suturing the tube to the patient's nose or lip.

Whatever method or device that is used to secure the tube should be reassessed periodically, as swelling can cause excessive pressure to the patient's face.

Carbon monoxide or other toxic chemical inhalation can also be seen in burn patients. This is especially true for those who were involved in a

[17]J. H. Brice, R. G. Pirrallo, E. Racht, B. S. Zachariah and J. Krohmer, "Management of the Violent Patient," *Prehospital Emergency Care,* 7.1, January/March 2003, pp. 48–55.

[18]Charly D. Miller, "Restraint Asphyxia—Silent Killer: The Pathophysiology of Restraint-Related Positional Asphyxia." *Merginet News,* Nov. 2000, Parts 1–3, www.merginet.com. Also at www.charlydmiller.com.

fire in an enclosed space. Oxygen saturation devices can be misleading in patients with high levels of carboxyhemoglobin (carbon monoxide bound to hemoglobin). The devices will indicate 100% saturation, but hemoglobin may have very little oxygen attached.

If advanced airway procedures are not available, escorts should be prepared to ventilate their patients with a bag-valve-mask or mouth-to-mask. Airways may be difficult to maintain, particularly if there is swelling in the airway.

Breathing

In addition to airway edema, respiration can be compromised when patients have third degree burns all the way around their chests (circumferential burns). These burns restrict the expansion of the chest wall. Presence of circumferential chest burns is an indication for escharotomy of the chest (see diagram on page 187).

Circulation

The patient with significant burns will need vigorous fluid resuscitation to maintain adequate circulation and to prevent and/or treat shock. To accomplish this, start peripheral IV lines with 16-gauge catheters or larger. Lactated Ringer's is the solution of choice. Ideally, IVs should be placed in non-burned areas, but if nothing else is available, IVs may be placed through burns. The Parkland formula is recommended in the Alaska Prehospital Trauma Guidelines. The following chart may be useful to assist in calculating fluid replacement volumes in patients with burns using the Parkland formula:

Parkland Formula

Time for Fluids	Recommendation
First 24 hours after burn injury	Administer 4 ml Lactated Ringer's (LR) x Patient's weight in Kg x percent Body Surface Area (BSA) burned. • Half of this amount is to be given in the first 8 hours after injury. This means that if the air medical escort arrives 3 hours after the patient is burned, the escort will want to give this entire volume over the next five hours to ensure that the patient has adequate volume resuscitation. • The remaining half is to be given over the next 16 hours.
Second 24 hours after burn injury	• Give enough normal maintenance fluids to maintain a normal urinary output. Colloids may be given under the direction of the burn center physician, if available.

Hypothermia in Burn Patients

Hypothermia is a potential complication in patients with severe burns. Skin plays an important role in the body's ability to regulate temperature. When the skin is damaged, it can no longer assist in maintaining body temperature. In patients whose burns exceed 10% BSA, dry dressings or a clean sheet should be placed over the burned areas after the burning process has been stopped. Often it is cool inside aircraft. Keeping patients warm and dry will help prevent hypothermia.

Monitoring

Medical escorts should monitor patients with severe burns. This monitoring includes:

- Vital signs.
- General condition.
- Urine output. Oliguria, or low urine output, during the first 48 hours after a burn injury generally indicates inadequate fluid resuscitation.

Patients who have electrical burns should be placed on a cardiac monitor. Fluid requirements for these patients are greater than those predicted by the Parkland Formula, which is based only on surface area burned. Electrical burns are like an iceberg; the visible burns on the skin may only be a small percentage of the total area burned.

If a large amount of hemoglobin or myoglobin is in the urine (the urine can appear red or brown in this situation) it is important to ensure a high urinary output until the urine is grossly clear, to help prevent acute renal failure. The urine can be alkalinized by giving sodium bicarbonate intravenously [44–50 mEq of NaHCO3 per liter of lactate ringer (LR)] until visible pigment is no longer seen. If urinary output does not respond to increased fluid administration, 12.5 gm mannitol can be added.

BLS Interventions

- Administer 100% oxygen. Humidified oxygen is preferred.
- Assist patients with ventilations as needed with a bag-valve-mask.
- Use moist sterile dressings on small burns (under 10% BSA) and dry sterile dressings on burns that exceed 10% BSA.

ALS Interventions

- Insert at least two large-bore IVs. Fluid resuscitation should be calculated with a burn formula such as the Parkland Formula. If the patient has electrical burns with pigment (hemoglobin or myoglobin) visible in the urine, sodium bicarbonate and mannitol might be helpful.

- Cardiac monitoring is important in patients with burns, especially electrical burns.

- Give IV morphine in repeated smaller doses to titrate effective pain control. Monitor for respiratory depression.

- Insert a Foley catheter with urimeter bag to accurately monitor fluid status. Follow the Alaska Prehospital Trauma Guidelines for maintenance of fluids. The current recommendation is to maintain urine output between 30–50 ml/hour in adults and at 1 ml/Kg body weight up to 30 Kg body weight in children.

- Patients with burns covering more than 25% BSA will almost invariably have ileus during the immediate post-burn period. Use an NG tube to reduce the likelihood of vomiting.

- Give a tetanus prophylaxis if the patient's most recent tetanus booster was more than five years before the burn injury. Give tetanus immune globulin (TIG) to people who have not undergone previous tetanus immunization.

- Consider escharotomy in patients with full-thickness circumferential burns of the chest or extremities before transport. Failure to do so could lead to respiratory compromise or loss of circulation in the limbs.

Pediatric Considerations

- Hypoglycemia is associated with fluid resuscitation in infants. Follow the Alaska Prehospital Trauma Guidelines for treatment of pediatric burn patients. Caregivers should check glucose levels every four to six hours in pediatric patients. Air medical escorts should consider using a fluid with 5% dextrose if glucose values are low.

- Child abuse must be considered when a child has suspicious burns. These include a child with burns to the:

    - Back.

    - Buttocks.

    - Posterior neck.

    - Circumferential scald burns of the hands or feet that are clearly demarcated and uniform with no splash marks.

Diagram shows the preferred sites of escharotomy incisions. (*Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice*, 13th ed. WB Saunders, Philadelphia, 1996 p. 221.)

Obstetrical Emergencies

Every pregnant patient has the potential to deliver in the aircraft. Therefore, the team transporting an obstetrical patient should be prepared to manage two patients. They must be prepared to manage:

- A delivery.

- A post-partum patient.

- A neonatal patient.

Appropriate equipment is important as well. This can include:

- An isolette.

- Tocolytic medications (medications that suppress uterine contractions).

- An OB kit.

- Appropriate equipment to assess and treat a depressed newborn.

Proper preparation also means that the crew has training and experience in delivery and neonatal resuscitation. Physicians arranging transportation for obstetrical patients must weigh the risks and the benefits of using a general air medical transport service or contact a team specializing in the care of obstetric and neonatal patients.

General Obstetrical Assessment

Women who are pregnant should be given a thorough assessment. Some specific things to check in the obstetric patient include:

1. The age of the patient.

2. The number of times the patient has been pregnant, or Gravida (G). This number includes the current pregnancy.

3. The number of deliveries after 20 weeks of gestation, or Para or Parity (P).

4. The number of abortions (Ab). The term "abortion" in this case means the number of pregnancies that ended before 20 weeks and includes miscarriages.

5. The date of last menstrual period (LMP).

6. The estimated date of confinement (EDC), also known as the "due date," calculated by this formula:

   LMP – 3 months + 7 days = EDC

7. Information from any ultrasound during this pregnancy, which may include the gestational age of the fetus, placental location, fetal presentation, the amount of amniotic fluid present, and any anomalies.

8. An obstetrical history covering the following questions:

   - Has the patient had any prior deliveries? If so, what was the gestational age of the fetus at birth?

   - How were any previous children delivered (vaginal birth or C-section)?

   - Has she had any complications from past deliveries?

   - Has the patient had any complications from past pregnancies?

- Has she had any spontaneous or elective abortions?
- How many living children does the patient have?
- Has there been more than a year between pregnancies?
- Has she had any multiple gestations?

9. Information about the current pregnancy covering the following questions:

- Is she experiencing contractions? If so, when did they begin and what is their frequency and intensity?
- Is she bleeding or have a bloody show? If so, does she feel pain with the bleeding? If she is bleeding, is the blood bright?
- Have the membranes ruptured? If so, is there or was there a gush or a trickle of fluid and is it or was it dark or clear fluid?
- Does she smoke? Does she use or abuse alcohol or other drugs?
- Has she had adequate weight gain?
- What prenatal care has she received?
- Has she noticed any change in fetal activity in the past several days?

10. Assess the patient's vital signs and recheck them every 15 minutes.

11. Monitor the fetal heart tones (FHT). Escorts should note any changes in the rate during contractions (increase or decrease). Fetal heart monitoring is the preferred method to track the fetal heart rate.

12. Measure fundal height in centimeters from pubic symphysis to the top of the uterus.

13. Palpitate the fundus lightly to determine strength, frequency, and duration of contractions.

14. Determine the fetal position by palpation. Escorts should note the position of the fetus' head and buttocks.

15. An air medical escort may assess the cervical status with a sterile exam if there is no bleeding, the patient's membranes are intact, and the escort had been appropriately trained and authorized to do so by his/her physician medical director.

16. Observe for other risk factors.

NOTE: Imminent delivery is a relative contraindication for flight.

Vaginal dilation greater then six cm in a first pregnancy (prima gravida) patient

or

active labor in a woman who has been pregnant more than once (multipara)

are strong indications that delivery should occur before flight.

BLS Interventions

- Place the patient in a left lateral recumbent position to keep pressure off the inferior vena cava.
- Some services place the pregnant woman with her head toward the rear of the aircraft to minimize the G-forces on the uterus during take-off. Follow agency protocols.
- Administer oxygen to the mother. Altitude can cause hypoxia in both the mother and the baby.
- Have an emergency delivery kit immediately available.
- Follow protocols for emergency delivery as required.
- Monitor fetal heart tones before, during, and after contractions.
- Monitor contractions for frequency and intensity.
- Treat vaginal bleeding as needed, monitor for early signs of shock.

ALS Interventions

- Start one or two IV lines prior to loading the patient on the aircraft. This will allow for the administration of fluids and medications if needed.

It is best for women with high-risk pregnancies to be transferred to a regional facility, with staff trained to manage the medical needs of these patients, **before** they are in labor.

Regional Facilities for Neonatal Patients

Facility Level	Hospital	Location
Level 3	Providence Alaska Medical Center	Anchorage
Level 2	Alaska Native Medical Center	Anchorage
	Alaska Regional Hospital	Anchorage
	Fairbanks Memorial Hospital	Fairbanks

The following are some conditions that may require transportation of the pregnant woman:

- **Preterm labor (PTL)**
  Preterm labor is defined as regular contractions that produce cervical changes and that occur between the twentieth and thirty-sixth week of gestation. There are many factors that can predispose the pregnant patient to preterm labor. The most common appears to be a sub-clinical infection of the urinary tract and vagina caused by a virus or bacteria. Infection is also thought to cause premature rupture of membranes. Rupture of membranes makes the patient more susceptible to preterm labor and delivery. The diagnosis of preterm labor can be made if there is a history of contractions every 10 minutes or less for at least an hour.

- **Premature rupture of membranes (PROM)**
  PROM is the rupture of the fetal membranes one hour or more prior to the onset of labor. The incidence of PROM occurs between 2%–17% of all pregnancies.[19] Some clinicians suspect that an undiagnosed sub-clinical infection, the most common of which is beta strep, is a cause of PROM. The diagnosis of PROM is made when the following factors are present:

  - There is pooling of amniotic fluid in the vagina.
  - Nitrazine testing of the fluid is positive.
  - A microscope slide of the fluid shows positive ferning.

  To assess for PROM, perform a sterile speculum exam to collect fluid found in the vaginal vault. A sample of fluid

[19]M. S. Wolkomir, G. P. Parsons, J. R. Damos, S. H. Eisinger, *Advanced Life Support in Obstetrics* (3rd ed.) American Academy of Family Physicians, Kansas City, 1996, p. 71.

is tested with nitrazine paper. The paper turns dark blue if amniotic fluid is present. Blood, cervical mucous, betadine, and some lubricants may give false-positive results. Hospital and clinic staff can confirm the results of the nitrazine paper test by spreading a small amount of the fluid on a microscope slide, and allowing it to dry completely. If amniotic fluid is present, a crystallized pattern will form which resembles a Boston fern when viewed under a microscope. Air medical crews generally do not perform this test.

PROM may or may not be accompanied by contractions, but this condition does increase the risk of preterm delivery.

- **Management of patients with PTL and PROM**
  - Administer IV fluids.
  - Ensure that the patient's bladder remains empty.
  - Frequently, tocolytic drugs are administered to slow or halt contractions and allow safe transport of the patient to a facility that can better meet the needs of the mother and unborn fetus. The most common tocolytic drugs used are terbutaline sulfate (Brethine®), and magnesium sulfate ($MgSO_4$).

Hemorrhagic Complications of Pregnancy

The two significant hemorrhagic complications of pregnancy that are important for air medical crews to be familiar with are placenta previa and placental abruption.

Placenta Previa is a condition in which the placenta implants itself in the lower segment of the uterus and covers the internal cervical os (opening of the cervix). Placenta previa is divided into three categories:

- Total placenta previa—the placenta covers the internal os completely.
- Partial placenta previa—the placenta covers only a portion of the internal.
- Low lying or marginal placenta previa—the placenta extends to, or is near the internal os, but does not cover any portion of the cervical os.

The diagnosis of placenta previa is usually made with an ultrasound. The classic sign of placenta previa is painless bright red vaginal bleeding. Fatal bleeding from placenta previa is rare in the absence of disruption of the placenta by digital exam or instrument.[20] If the location of the placenta is not known, air medical providers may decide to avoid a digital or speculum examination until an ultrasound is performed.

Placental Abruption (Abruptio Placentae) is the premature separation of a normally implanted placenta prior to the delivery of the infant. There are three classifications of placental abruptions:

- Marginal. The marginal separation usually occurs near the edge of the placenta and allows blood to escape from behind the placenta. Vaginal bleeding from a marginal placental abruption is often dark red.

- Concealed. A concealed abruption is a hemorrhage from the arterioles that supply the lining of the uterus during pregnancy. It causes a collection of blood behind the placenta, but the blood is trapped so there is no vaginal bleeding seen.

- Combined. A combined abruption is a combination of the marginal and concealed abruptions.

With both hemorrhagic complications, the patient usually has abdominal pain and tenderness associated with vaginal bleeding. The amount of pain varies from pain similar to menstrual cramps to severe abdominal or back pain. Painless abruptions are rare. The pain is associated with uterine contractions, which may feel very strong to the examiners hand.

Management of a Mild Preterm Abruption or Placenta Previa

Tocolytic therapy and bed rest may be the best management for these conditions. Differentiating between moderate and severe bleeding episode depends on the how much blood the mother has lost, how well her blood is clotting, as well as the response of the fetus. It is very important to assess and monitor maternal vital signs and urinary output closely; be alert for early signs and symptoms of shock.

Hypertensive Disorders of Pregnancy

Hypertensive disorders in pregnancy includes pre-eclampsia, eclampsia, pregnancy induced hypertension (PIH), and pregnant women who have chronic hypertension with superimposed PIH.

[20]M. S. Wolkomir, G. P. Parsons, J. R. Damos, S. H. Eisinger, *Advanced Life Support in Obstetrics* (3rd edition) American Academy of Family Physicians, Kansas City, 1996, p. 52.

Pre-Eclampsia is the development of hypertension along with proteinuria (protein in the urine), edema, or both after the 20th week of pregnancy.

Eclampsia can occur if pre-eclampsia progresses. Signs and symptoms of eclampsia are convulsions, cerebral vascular changes, hypoxia, and cerebral edema.

Pregnancy-Induced Hypertension (PIH) is used to describe several problems with high blood pressure associated with pregnancy. Hypertension is defined as readings of 140/90 or greater, an increase in mean arterial pressure (MAP) of 20 mm Hg, or a MAP of 105 mm Hg or higher. The elevated blood pressure must be present on at least two occasions, six or more hours apart. PIH is a significant cause of maternal and neonatal morbidity and mortality.

The clinical management goals of PIH are:

- Prompt diagnosis.
- Blood pressure control.
- Optimization of oxygen delivery to both the mother and fetus.
- Identification of the proper time for delivery.

Hypertension with Superimposed PIH is high blood pressure that is found in patients with chronic hypertension who were diagnosed with underlying hypertension before the 20th week of pregnancy. These women have an increased risk of:

- Superimposed PIH.
- Abruptio placentae.
- Intrauterine growth retardation.
- Intrauterine fetal death.

HELLP Syndrome is not a hyptertensive disorder of pregnancy in and of itself, but it is considered a complication of severe pre-eclampsia. It stands for hemolysis, elevated liver enzymes, and low platelets. Patients with this condition may have complications, which can include clotting disturbances, renal failure, pulmonary edema, hepatic rupture, and fetal and/or maternal death.

Stabilization and management of patients with PIH and HELLP Syndrome is very challenging. Careful monitoring of the following items is vital:

- Maternal hemodynamic status.
- Maternal respiratory status.
- Maternal neurological status.
- Fluid intake and output.
- Fetal status.

Patients with pregnancy-related hypertensive disorders may be put on an infusion of magnesium sulfate ($MgSO_4$) and antihypertensive medication.

Neonatal Transport

The use of a neonatal specialized team should be considered when arranging neonatal transports. Even a healthy newborn can decompensate rapidly in the air medical environment. Some newborns may develop respiratory distress that requires immediate intervention shortly after birth. Newborns have a large body surface area that causes them to lose heat rapidly. Cold stress can lead to respiratory distress and can cause infants to use up their glucose stores, leading to hypoglycemia.

Neonates can decompensate even after extensive stabilization is preformed on site. When transporting neonatal patients, the following things should be available:

- An isolette with controlled oxygen levels and strict temperature regulation. In rare situations, it may be necessary to transport a neonate when an isolette is not available. In this case, an isolette can be made by using a box with a heating pad and plenty of blankets to prevent the infant from losing too much heat, along with blow-by O_2 and a conventional monitor.
- Patient monitor.
- One or more escort(s) with training in neonatal resuscitation.

- IV access.
- Airway management equipment.

BLS Interventions

- Keep the isolette closed and insulate it with additional covers in extreme cold to protect the infant from hypothermia.
- Clamp the umbilical cord and keep it dry during transport to allow umbilical catheterization to be done at the receiving facility, should the need arise.
- Monitor the infant's heart rate, respiratory rate, temperature, and pulse oximetry during flight.
- Place infants on either their backs or sides with safety straps to hold them securely on the mattress.
- Consider eye protection for a sensitive or unstable infant. Hearing protection should be provided to all infants.

ALS Interventions

- Consider placement of a feeding tube in the infant prior to transport to decompress the stomach and decrease diaphragmatic compromise.
- Use soft limb restraints to prevent an active infant from inadvertent pulling on lines or tubes, if necessary.

Pediatric Transport

Children present a number of challenges when they are transported by air. They:

- React differently to stress and medications.
- Suffer distinct types of injuries.
- Are different from adults anatomically, physiologically, and psychologically.
- Can decompensate rapidly.

It is essential that pediatric patients receive:

- Optimal airway management.
- Adequate ventilation and oxygenation.
- Fluid resuscitation immediately when appropriate.
- Glucose monitoring, as small children can deplete glucose stores rapidly. Low blood glucose requires rapid administration of glucose.

Air medical escorts who transport pediatric patients must have a basic understanding of pediatric assessment and patient management. Devices such as the Broselow® tape (a length-based pediatric assessment tool) and commercially-available pediatric care guides are available to assist escorts. For the very young, or critically ill pediatric patient, it may be better to contact a pediatric air medical transport service.

Psychological Needs of Pediatric Patients

A child is very dependant upon parents and caregivers for security. Parents and caregivers should accompany children whenever it is possible. They may be able to calm their children and encourage patient cooperation allowing better care.

Respiratory Emergencies

Pediatric patients are at increased risk for hypoxic hypoxia (hypoxia secondary to altitude) due to their high metabolic rate and higher metabolic needs. It is essential for air medical escorts to give unstable pediatric patients oxygen during air medical transport.

The leading cause of preventable death in pediatric emergencies is some type of compromise of the airway or of breathing. Children must be monitored closely for signs of impending respiratory distress that can progress to respiratory failure. Oxygen saturation monitoring equipment is useful, but air medical escorts should remember that a child could maintain normal O_2 saturation levels—then rapidly desaturate.

Signs of Respiratory Distress vs. Respiratory Failure

Factor	Distress	Failure
Appearance	Normal or mildly agitated	Unaware of surroundings or limp and unresponsive

Signs of Respiratory Distress vs. Respiratory Failure		
Breathing	Tachypnea, use of accessory muscles, retractions, increased work of breathing	Bradypnea, gasping or apnea
Circulation	Normal or mildly tachycardic	Bradycardia, cyanosis, pale

Respiratory emergencies in children should be treated with high-concentration oxygen. Oxygen should be humidified, if possible. Appropriate delivery devices include:

- Pediatric sized non-rebreather masks.
- Pediatric nasal cannulae.
- Face shields.
- Oxygen hoods.

Airway management can be problematic in pediatric patients. Proper positioning is essential. This may include padding under the child's shoulders. Blow-by oxygen is often used for children who resist masks. Placing oxygen tubing through the bottom of a cup or with a mask directed towards the child can be beneficial. Parents can administer nebulized medication using a similar technique.

Advanced airway measures can be difficult for inexperienced providers. Good basic airway management is essential. Escorts should consider intubating pediatric patients before transport, if the patient has any sign of impending airway obstruction or respiratory compromise.

If a child stops breathing, the escort should provide ventilations with a bag-valve-mask and high-flow oxygen.

It is possible to hyperventilate or over-inflate the lungs in pediatric patients.

- Escorts should use only the volume needed to make the chest rise.
- Escorts should monitor the respiratory rate closely, and maintain ventilations at the rate normal for the child's age.

The use of end tidal CO_2 monitoring can help gauge whether excessive ventilations are being provided. If the pediatric patient is over-ventilated, the CO_2 level will fall. This can lead to acid/base imbalance and seizures.

Cardiovascular Emergencies

Almost all sick pediatric patients are somewhat volume depleted. It is important to recognize volume depletion early to prevent the development of shock. Children will compensate for hypovolemia for a long time, and then rapidly decompensate. Blood pressure is an unreliable measure of shock/fluid status in pediatric patients. Capillary refill greater than 2 seconds is an early indication of circulatory compromise.

Signs of Shock: Compensated vs. Decompensated Shock

Factor	Compensated Shock	Decompensated Shock
Appearance	Normal or mildly agitated	Unaware of surroundings or limp and unresponsive
Breathing	Rate normal or faster than normal Increased work of breathing	Bradypnea, gasping or apnea
Circulation	Tachycardic, delayed cap refill 3–4 seconds, normal BP	Bradycardia, cyanosis, pale, decreased BP

It is essential that fluid resuscitation be started early. Ringer's Lactate or normal saline can be used. The dosage for pediatric fluid resuscitation is 20 cc/kg, which is usually given as a bolus. The patient is reassessed after each bolus, and the bolus can be repeated as needed. Blood sugar should be checked after resuscitation with fluids. In the case of air medical transports, IVs are generally inserted and carefully secured prior to transport. Intraosseus (IO) lines can be used as an alternative vascular access method in critically ill children. They should be inserted according to protocol. A stopcock and a large syringe can be used to deliver the recommended fluid boluses.

Securing Pediatric Patients for Transport

Children must be properly immobilized in approved age and weight appropriate restraints. Stable children (e.g. those with mild respiratory distress) may be transported in a child car seat. Pediatric spine boards are available for pediatric trauma patients. In some situations children are too combative or their respiratory distress dramatically worsens when separated from his/her parent. In these situations, it may be advisable to transport the child in the parent's arms. To do this safely, restrain the parent on the stretcher and then position the child in his or her arms. This allows maximum security for the child while still maintaining a measure of safety.

BLS Interventions

- Perform a developmentally appropriate patient exam.
- Ensure age and weight appropriate immobilization devices are available.

- Plan and implement developmentally appropriate distraction measures.
- Monitor glucose levels and urine output closely.
- Maintain normal body temperature. Children lose heat more easily than adults.
- Maintain contact with the parent/caregiver if possible.
- Consult with pediatrician if possible.
- Avoid strapping over the abdomen in patients under 10 years old as it may interfere with respirations.

ALS Interventions

Use a Broselow® tape, or other length-based resuscitation device, to calculate weight-specific medication doses, sizes of resuscitation equipment, and code procedures (e.g. joules required for defibrillation, etc.)

- Use an orogastric or nasogastric tube for any child receiving assisted ventilations.
- Ensure vascular access and provide fluid resuscitation as needed. IO access may be needed for critically ill children.

Summary

Many medical conditions can worsen when a patient must be flown to a facility for treatment. Problems that result from air expansion at altitude account for many of the complications seen during air medical transports. Decreased oxygen levels at altitude, aircraft movement, vibration, noise, and cooler temperatures found inside some aircraft cause other complications.

Many potential complications can be anticipated. It is best to be ready for possible problems before the patient is loaded onto a small aircraft. This may involve spending more time on the ground at the sending facility, but this is often in the patient's best interest. A thorough assessment, adequate preparation, and attentive monitoring of the patient during flight will help the patient get the best possible care during air medical transport missions.